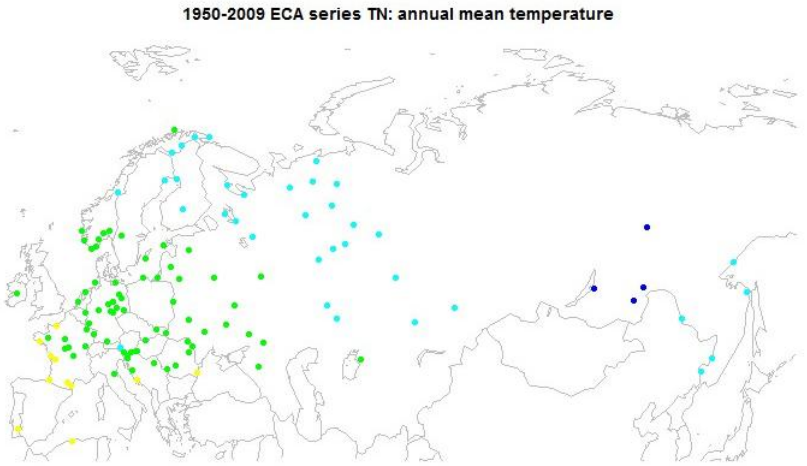
The role of variability in the change of temperature extremes

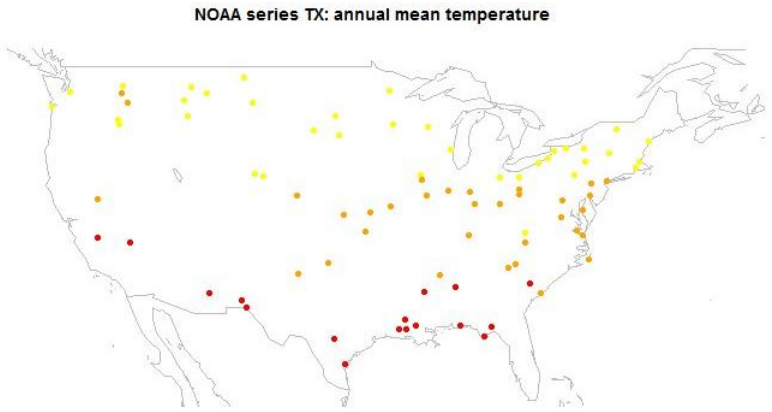
Sylvie Parey
EDF/R&D/MFEE
Acknowledgments to T.T.H. Hoang and D. Dacunha-Castelle

Datasets

- Europe: ECA&D 1950-2009
  - Homogenous (« useful »)
  - Tx, Tn
  - <3 years of missing data ⇒106 Tx series and 120 Tn series



- United States: NCDC, Global Historical Climatology Network
  - Series with <4 years of missing data
  - Beginning before 1966 and ending after 2008
  - 86 Tx series, 85 Tn series

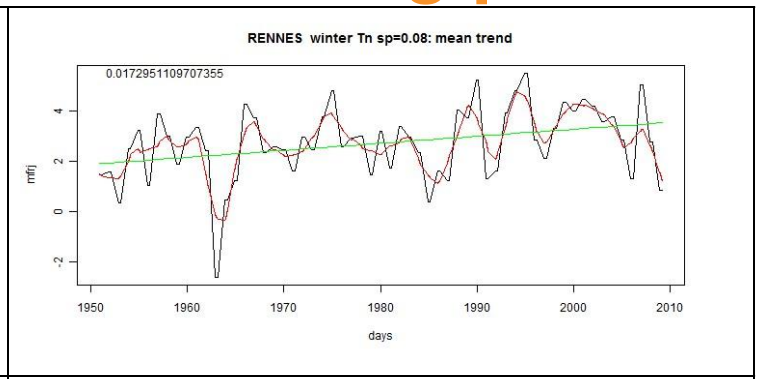
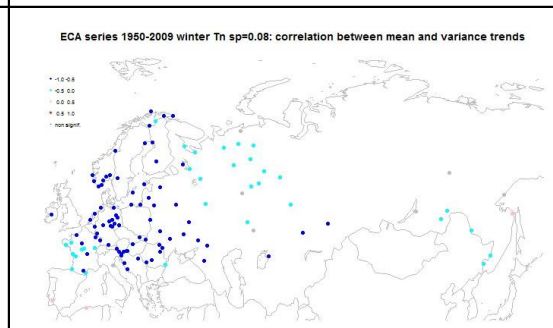
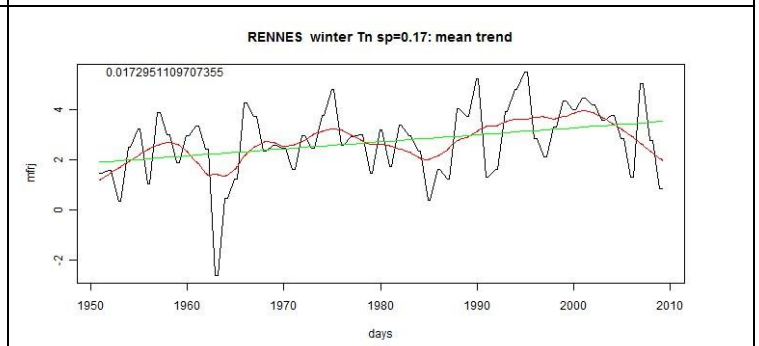
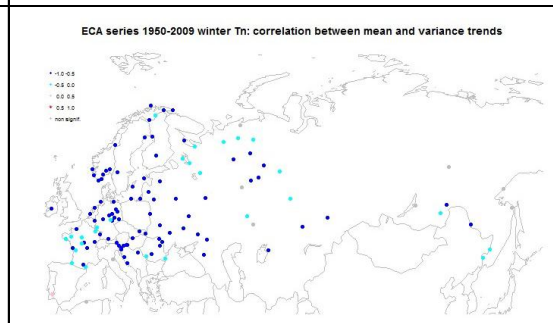
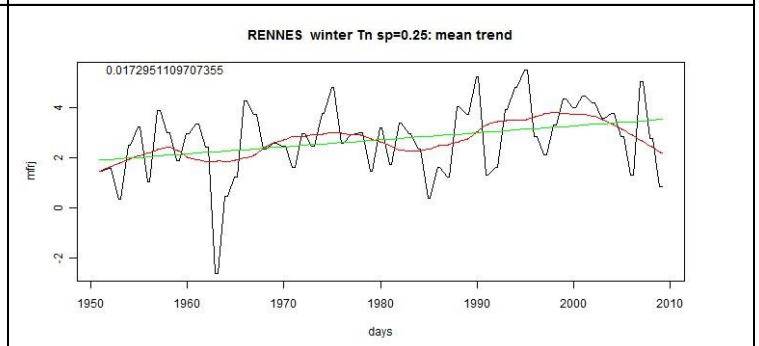
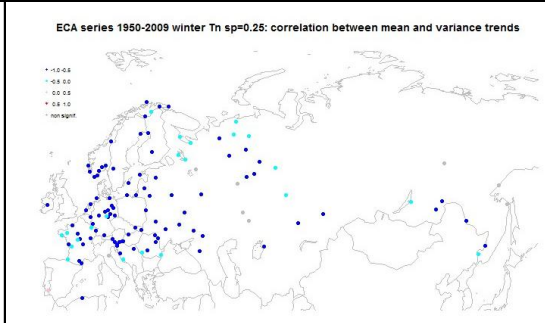


Methodology

- Extreme value theory
  - Block maxima + GEV
  - Summer = 14th June – 21st September (100 days) Winter = DJF (90 days)
  - 2 blocks per season

- Non parametric trend
  - Mean and variance
    - LOESS with modified partitioned cross-validation ⇒ smoothing parameter
    - Mean then variance
    - X : raw data, m: non parametric trend in mean, v: non parametric trend in std
      - $X_t \Rightarrow m_t$
      - $(X_t-m_t)^2 \Rightarrow v_t \Rightarrow s_t$
      - $Y_t= (X_t-m_t)/s_t$
  - Extremes
    - Non parametric: cubic splines with cross-validation for the smoothing parameter

The smoothing parameter

sp=0.08			
sp=0.17			
sp=0.25			

Winter TN

between -1.0 & -0.5
between -0.5 & 0.0
between 0.0 & +0.5
between +0.5 & +1.0
non significant

⇒ 0.17

Link with the extremes

$$Y_t = \frac{X_t - m_t}{s_t}$$

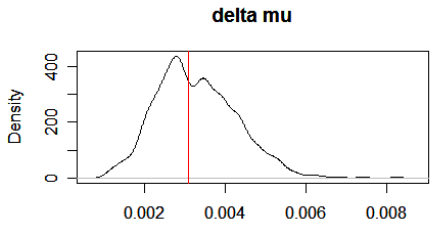
X_t is the observed series; m_t the trend in mean and s_t the trend in standard deviation

The hypothesis: the extremes of Y_t are stationary

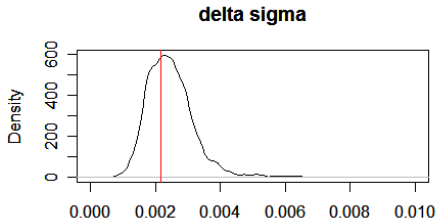
How to test this hypothesis?

1) define a distance between 2 time functions

$$\Delta(f,g) = \frac{1}{T}\left(\int (f(t)-g(t))^2 dt\right)^{1/2}$$



2) compute a statistical table for Δ using a stationary GEV



- 1000 or 500 samples of the stationary GEV law (ξ_Y, μ_Y, σ_Y)
- Estimate GEV parameters: 1) constant 2) time varying
- Compute Δ

Results

Winter Min Tn

- OK for mu & sigma
- OK for mu only
- OK for sigma only
- NO
- non convergence

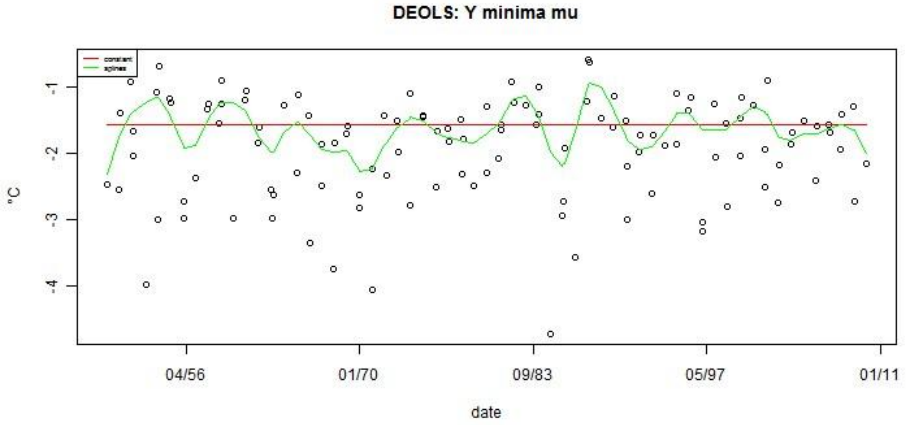
Déols

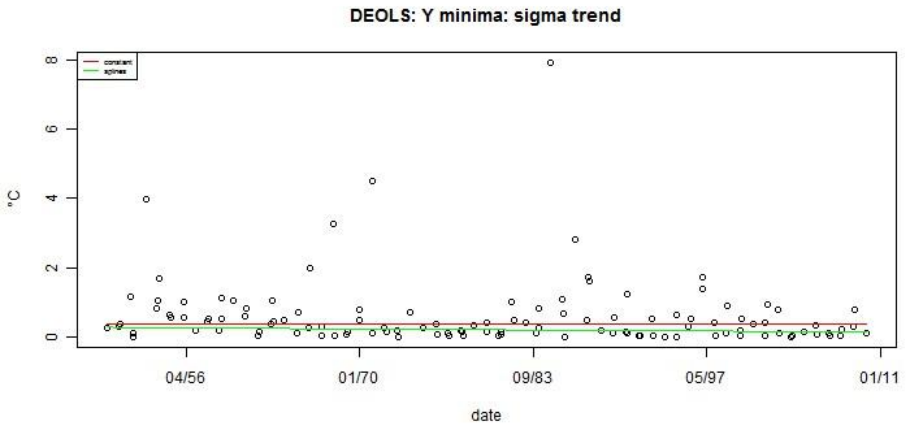
Lafayette

Summer Max Tn

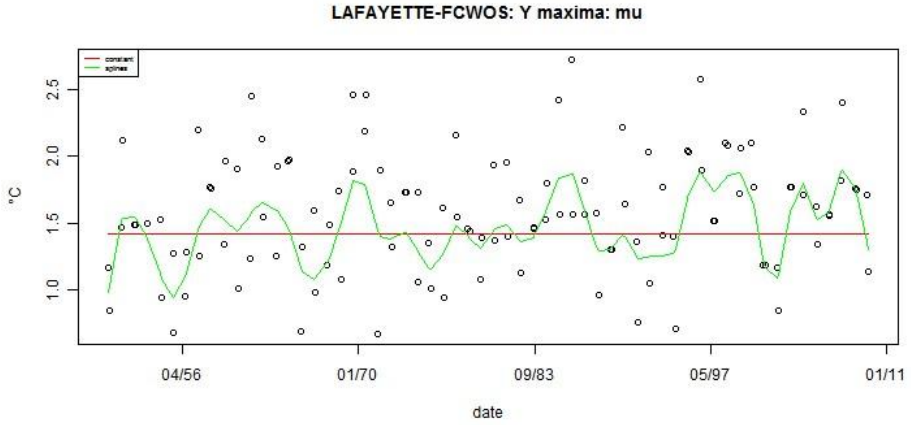
Still a trend in extremes?

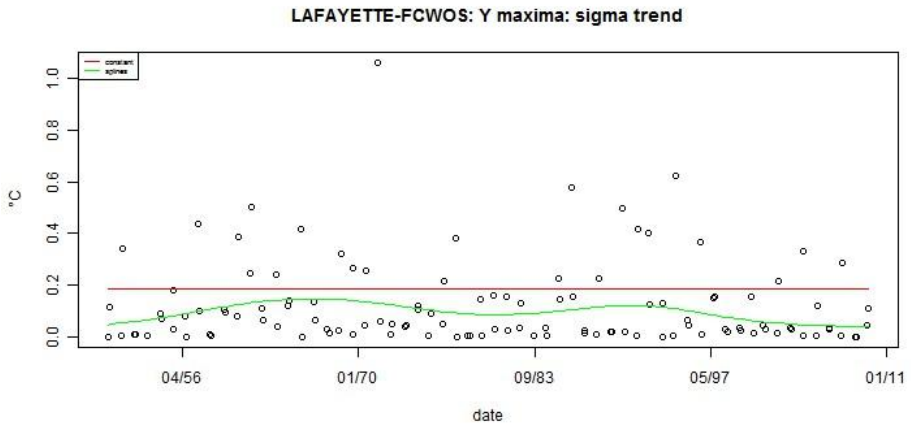
Winter Min Tn in Europe





Summer Max Tn in the US

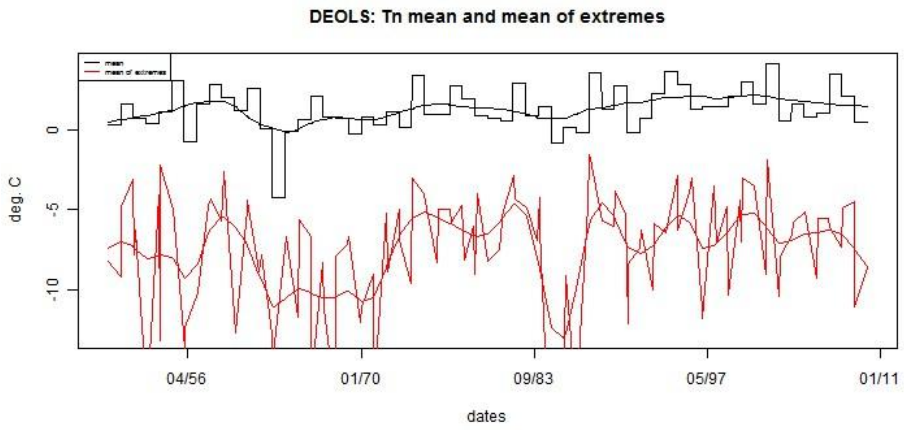


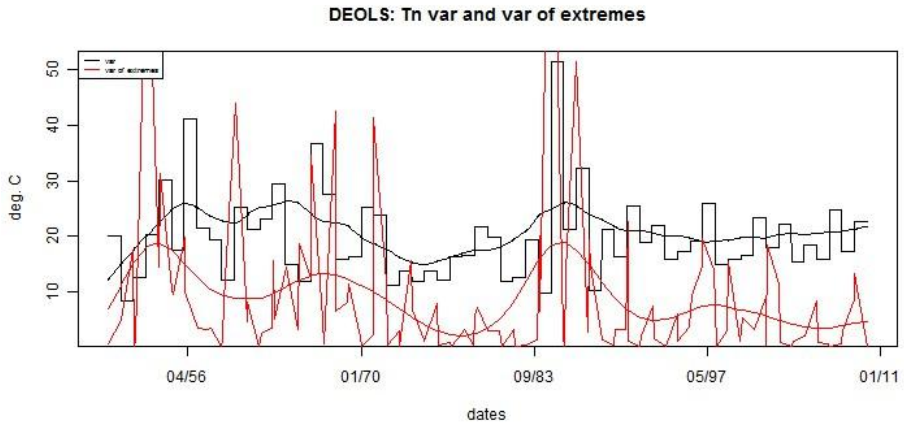


EDF

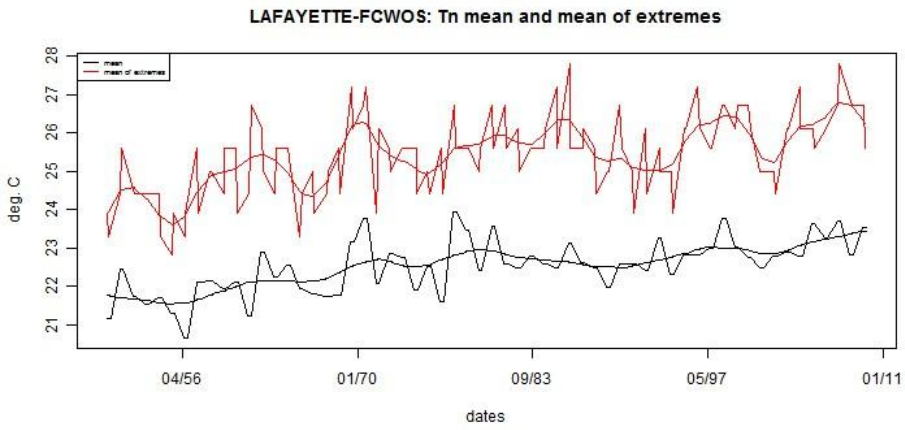
Role of the smoothing

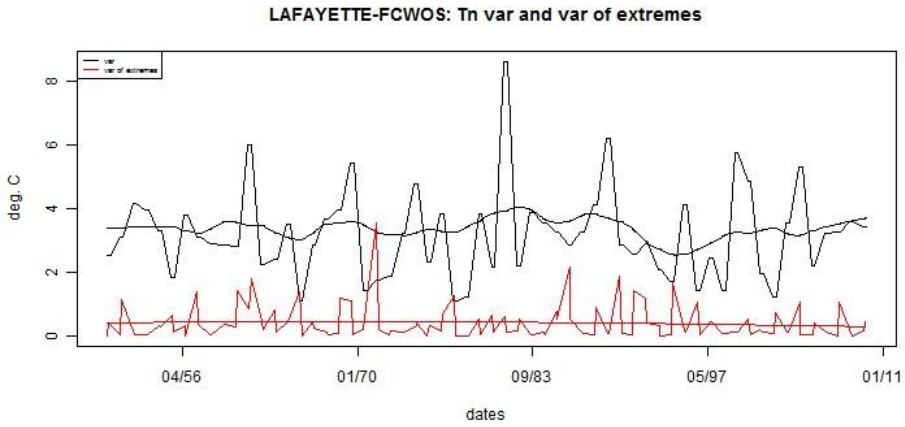
Winter Min Tn in Europe





Summer Max Tn in the US

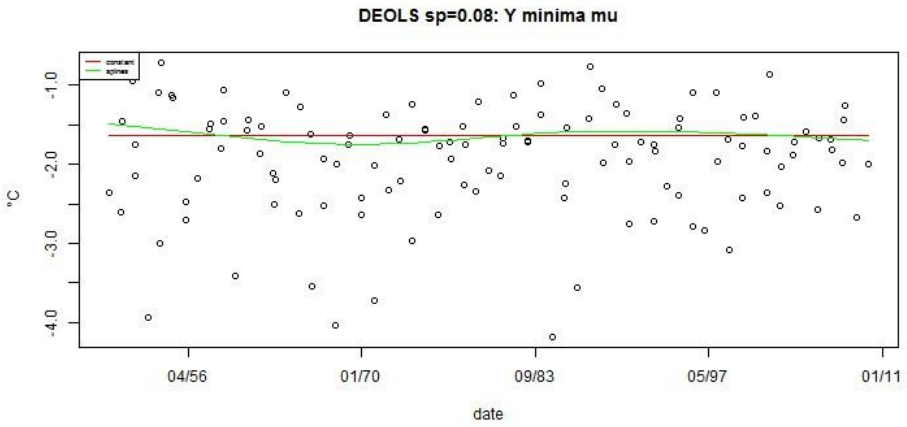


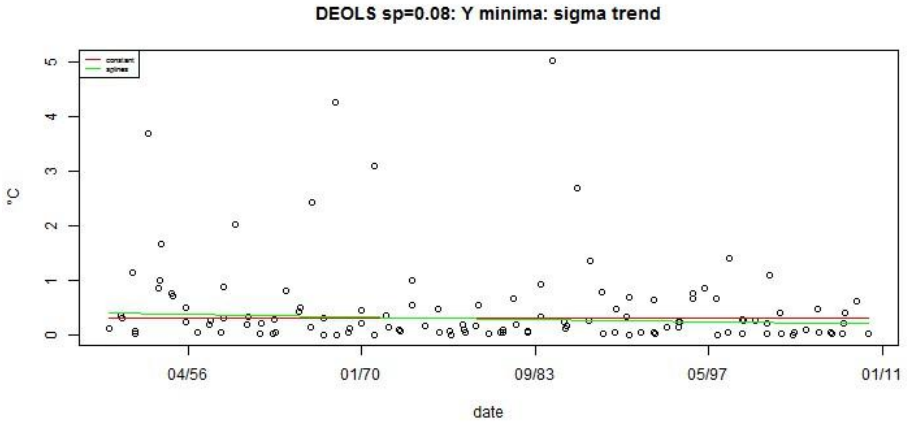


Optimal smoothing for the mean: 0.08

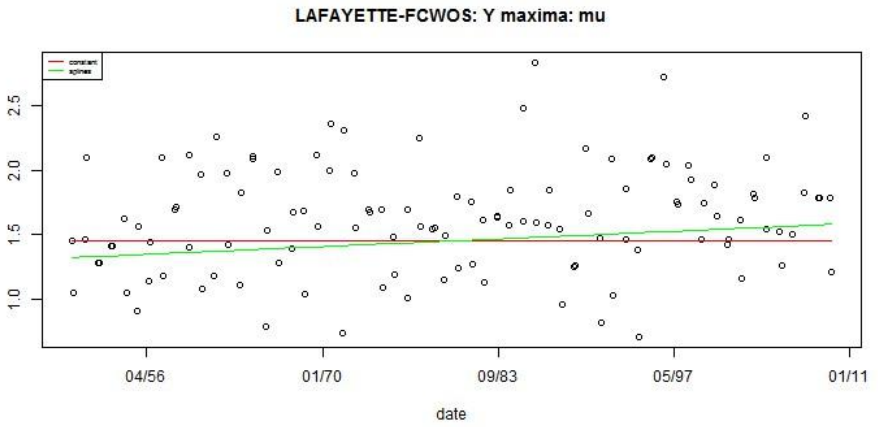
Y computed with the optimal sp

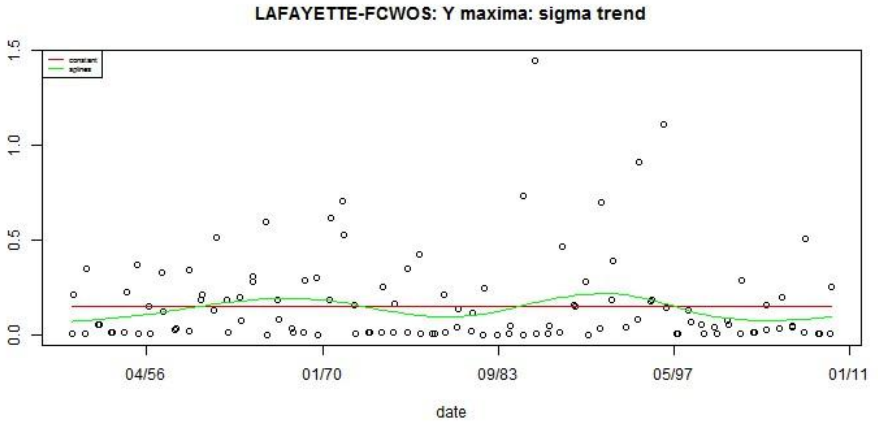
Winter Tn in Europe





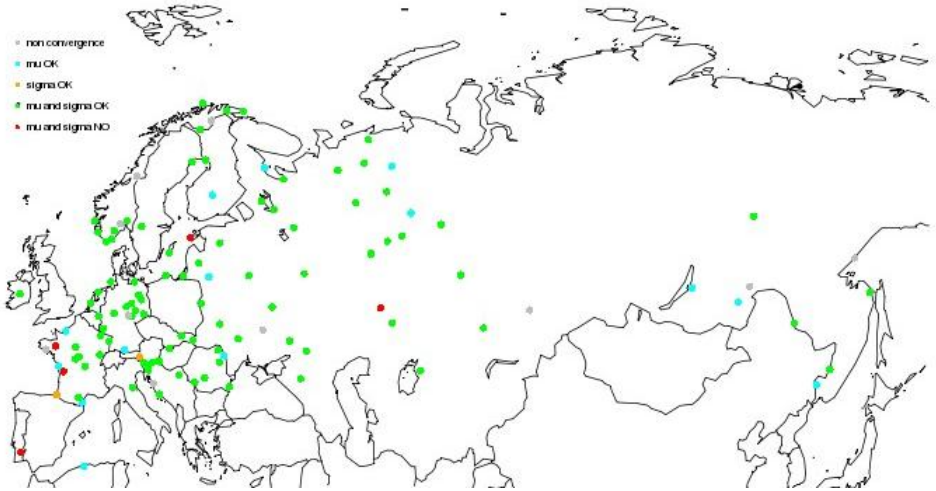
Summer Tn in the US





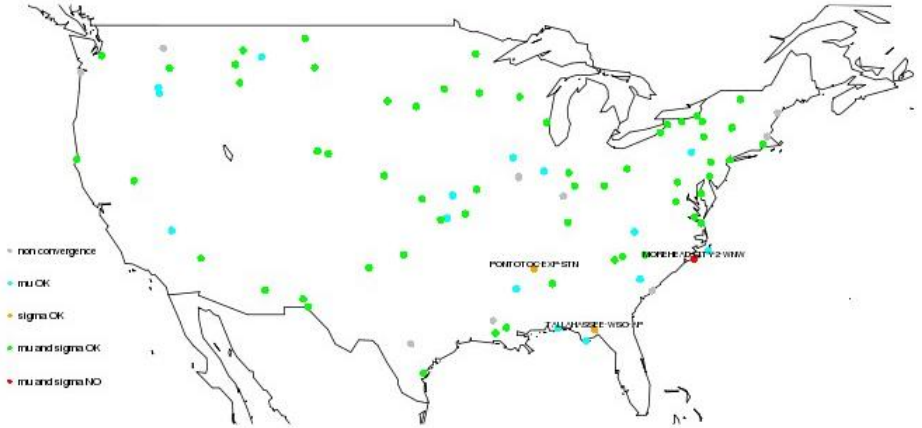
Y extremes stationarity

ECA series 1950-2009 winter Tn: optimal sp



- OK for mu & sigma
- OK for mu only
- OK for sigma only
- NO
- non convergence

NOAA series 1950-2009 summer max Tn: test



Conclusion

- Link between trends in extremes and mean and variance
  - Europe and the United States
  - Winter Min Tn and Tx, Summer Max Tx and Tn
  - EVT and non parametric trends
  - Link between trends in mean and variance
    - Negative correlation in winter
    - Positive correlation in summer in Europe, more balanced in the United States

- Stationarity of the extremes of Yt
  - Generally OK, but only if interannual variability is correctly removed

Thanks for your attention

EDF